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**ABSTRACT**

A method for processing a received, modulated pulse (*i.e.* waveform) that requires predictive deconvolution to resolve a scatterer from noise and other scatterers includes receiving a return signal; obtaining  $L + (2M-1)(N-1)$  samples  $y$  of the return signal, where  $y(\ell) = \tilde{\mathbf{x}}^T(\ell) \mathbf{s} + \mathbf{v}(\ell)$ ; applying RMMSE estimation to each successive  $N$  samples to obtain initial impulse response estimates  $[\hat{x}_1\{-(M-1)(N-1)\}, \dots, \hat{x}_1\{-1\}, \hat{x}_1\{0\}, \dots, \hat{x}_1\{L-1\}, \hat{x}_1\{L\}, \dots, \hat{x}_1\{L-1+(M-1)(N-1)\}]$ ; computing power estimates  $\hat{\rho}_1(\ell) = |\hat{x}_1(\ell)|^2$  for  $\ell = -(M-1)(N-1), \dots, L-1+(M-1)(N-1)$ ; computing MMSE filters according to  $\mathbf{w}(\ell) = \rho(\ell) (\mathbf{C}(\ell) + \mathbf{R})^{-1} \mathbf{s}$ , where  $\rho(\ell) = |x(\ell)|^2$  is the power of  $x(\ell)$ , and  $\mathbf{R} = E[\mathbf{v}(\ell) \mathbf{v}^H(\ell)]$  is the noise covariance matrix; applying the MMSE filters to  $y$  to obtain  $[\hat{x}_2\{-(M-2)(N-1)\}, \dots, \hat{x}_2\{-1\}, \hat{x}_2\{0\}, \dots, \hat{x}_2\{L-1\}, \hat{x}_2\{L\}, \dots, \hat{x}_2\{L-1+(M-2)(N-1)\}]$ ; and repeating (d)-(f) for subsequent reiterative stages until a desired length- $L$  range window is reached, thereby resolving the scatterer from noise and other scatterers. The RMMSE predictive deconvolution approach provides high-fidelity impulse response estimation. The RMMSE estimator can reiteratively estimate the MMSE filter for each specific impulse response coefficient by mitigating the interference from neighboring coefficients that is a result of the temporal (*i.e.* spatial) extent of the transmitted waveform. The result is a robust estimator that adaptively eliminates the spatial ambiguities that occur when a fixed receiver filter is used.

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